

A NEW PHOTOFIT OR CONCEPTUAL MODEL OF THE ELECTRON, DERIVED FROM THEORETICAL AND EXPERIMENTAL PHYSICS PAPERS

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ABSTRACT

The electron was discovered in 1897 by physicist J. J. Thomson when studying cathode rays, which he initially called corpuscles. Properties of the electron like charge, mass and spin could be measured, but nobody knew what caused them. The electrons were therefore believed by many to be weird point particles with no substructure, to which their properties were simply attached. The origin of the electromagnetism phenomenon (unknown exactly so far) in general was exclusively attributed to the intrinsic (unseen) mechanics of the electron itself. Each electron is able to produce an electromagnetic field that may extend throughout space. After a century of efforts, the essence and specific form of the intrinsic electron spin have not been revealed because of the intrinsic spin of an electron was classically thought of a spinning ball of negative charge. There is even really not having a good picture for what spin for point particles means (due to counter-intuitive behavior of the electron accepted as a point particle). If an electron were a physical spinning ball of negative charge its edge would indeed have to spin faster than the speed of light to produce its observed angular intrinsic spin momentum, making the classical concept of intrinsic electron spin-as-rotation invalid. The reason is probably that the electron is constrained by the concept of point particle material structure. Later on, the literature has got more conceptual electron models like vortex, toroidal and Hubius helix, etc. shapes but still with deficiencies and inconsistencies not properly explaining the intrinsic spin concept and the relationship and the interaction between the electron and the photon. It looks like the electron has not been fully and correctly understood. It was thought that the humble looking electron may be hiding some surprises in its depths. A physical photofit or conceptual (thought) model of the electron is derived from theoretical and experimental physics papers in this study. This model is intuitively believed to reveal a new intrinsic magnetic properties of the electron and the vital relationship and the interaction between the electron and the photon. In the photofit model, the electron as a negative charged hollow sphere continuously contracts (to oblate spheroid) and expands (or relaxes to be perfect sphere again) to create magnetic fields and ejects photons (at the speed of light) entering in hollow part of the spherical electron by compressive and expansive mechanical forces (in resonance) created by the attractive and repulsive electrostatic and magnetic forces due to moving charges of the electron. A new reasonable concept of intrinsic magnetic spin is also provided due to the compressive & expansive movement of charges inside the electron. So the spin is no longer thought as angular but the intrinsic compressive & expansive type.

Key words: spherical coordinate system, oblate spheroidal coordinate system, intrinsic angular momentum, uncertainty, electron, positron, photon, spin, wave-particle duality, compressive & expansive spin, attraction and repulsion, photon exchange, $\frac{1}{2}$, recoil, 720°

Glossary of Symbols and Abbreviations:

SRSC: Square Root Scaled Chart
SpCS: Spherical Coordinate System
C&E: Compressive & Expansive

HoSpCS: Hollow Spherical Coordinate System
OSCS: Oblate Spheroidal Coordinate System
PSCS: Prolate Spheroidal Coordinate System

I Introduction

When teaching the electromagnetics at undergraduate levels, **the electricity** is called or explained as **severe impact** (*siddetli çarpma* in Turkish) in two words and **the magnetic** is called or explained as **attraction** (*çekme* in Turkish) in one word [1,2], and the light (or the photon) is called or explained as **reflection** (*yansım*a in Turkish) in one word. The combination of the electricity and the magnetic is known as the electromagnetics which requires a good knowledge of an interaction between the electron and the photon in addition to inner structure (and dynamic behaviour) of the electron and behaviour of the photon. The electrons were believed by many to be point particles with no substructure, to which their properties (charge, mass and spin) were simply attached. The origin of the electromagnetism (even exact shape of the electron) phenomenon (unknown so far) in general was exclusively attributed to the intrinsic (unseen) mechanics of the electron itself. While these questions remain in mind, in other earlier studies which are related to the Double Slit Experiment [3] and Heisenberg Uncertainty Principle [4] are another sources of questions (producing curiosity) like

- what is the cause of quantum uncertainty?
- does the interference pattern on a screen in the double-slit experiment differ depending on whether light (photons) or electrons are applied?
- why do not we know where the quantum particle in an electromagnetic wave (packet)?
- what is the inner structure (and dynamics, material) of the electron and the positron?
- how an electron produces its magnetic field?
- is the inside repulsive force caused by electron's electric field greater than the attractive force caused by its magnetic field?
- can a wave and a particle be considered as in duality (or separable)?
- is the intrinsic spin momentum of the electron an angular type or compressive-expansive type?
- is there a classical analog of an electron's spin?
- what is the relationship between The Stern-Gerlach experiment and the intrinsic spin of the electron?
- why does the intrinsic magnetic spin of the electron execute Larmor precession instead of alignment along the magnetic field?
- what is the relationship between the Casimir effect and the relationship and the interaction between the electron and the photon?
- do the particles originate from nothing?
- what is the cause of the electrostatic and the magnetic repulsion and attraction between the electrostatic charges and the magnets?
- how does the electron interact with the photon?
- is the electron's field pure electrostatic or pure magnetic or a combination of both?
- is there repulsive forces inside the electron?
- how do the photons mediate electrostatic & magnetic attraction & repulsion between the electrons and the positrons?
- what is the difference between a photon and a virtual photon?
- where and how long does the photon reside in the electron? How many at one instant?
- how is the photon born at light speed?
- is it possible for a photon to be weightless? Is its energy converted to mass?
- why is the quantum world is probabilistic rather than deterministic?
- what is difference between the electron and the positron?
- is the electron and the positron alive?
- may the humble looking electron be hiding some surprises in its depths?
- is there a metaphysical mystery in the quantum world?
- does God not play dice with the universe?

require to be researched and investigated. These endless questions as a matter of curiosity are main motivation of this study.

Electrons play an essential role in numerous physical phenomena, such as electricity, magnetism, chemistry, and thermal conductivity; they also participate in electromagnetic, and weak interactions. Since an electron has charge, it has a surrounding electric field that generates a magnetic field. Electrons radiate or absorb energy in the form of photons when they are accelerated [5].

The electron was discovered in 1897 by physicist J. J. Thomson when studying cathode rays, which he initially called corpuscles (a minute particle regarded as the basic constituent of matter or light). Properties of the electron like charge, mass and spin could be measured, but nobody knew what caused them. After a century of efforts, the essence and specific form of electron (angular) intrinsic spin have not been revealed because of the spin of an electron was classically thought of a spinning ball of charge. There is even really not having a good picture for what spin for point particles means (due to counter-intuitive behavior of the electron as a point particle). If an electron were a physical spinning ball of charge its edge would indeed have to spin faster than the speed of light to produce its observed angular intrinsic spin momentum, making the classical concept of intrinsic electron spin-as-rotation invalid. The reason is probably that the electron is constrained by the concept of point particle material structure. Later on, the literature has got more conceptual electron models like vortex [6-8], horn torus [9], Hubius Helix [10], toroidal [11], etc. shapes but still with deficiencies and inconsistencies not properly explaining the intrinsic spin concept and the vital relationship and the interaction between the electron and the photon. The generally accepted model of the electron must accurately calculate the behavior of electrons when they interact with other electromagnetic systems and particles carrying mass and electric charge, dynamic behaviors such as spin resonance or oscillation, as well as the absorption and release of photons. It looks like that the electron has not been fully and correctly understood. It was thought that the humble looking electron may be hiding some surprises in its depths.

A physical photofit or conceptual (thought) model of the electron is derived from theoretical and experimental physics papers in this study. This model is intuitively believed to reveal the intrinsic magnetic (spin) properties of the electron and the vital relationship and the interaction between the electron and the photon.

In the photofit model, the electron as a negative charged hollow sphere continuously contracts (to oblate spheroid) and expands (or relaxes to be perfect sphere again) to create magnetic fields and ejects photons (at the speed of light) entering in hollow part of the spherical electron by compressive and expansive mechanical forces (in resonance) created by the attractive and repulsive electrostatic and magnetic forces due to moving charges of the electron. A new reasonable concept of the intrinsic magnetic spin is also provided due to the compressive & expansive movement of charges inside the electron. So the spin is no longer thought as angular but compressive & expansive type.

Proposed shape and dynamic behaviour of the electron, the vital relationship with the photon and explanation of the intrinsic compressive & expansive magnetic spin ($\frac{1}{2}$) are as follows.

II Photofit Model of the Electron: Geometric Explanation of the Shape of the Electron

Some properties of the electron (to be used in the photofit or conceptual model) currently are

- a negative charge: well known
- a mass: well known
- $\frac{1}{2}$ spin and a magnetic field: known theoretically (there is not a classical analog of an electron's spin) but its origin is unknown (it looks impossible to know without discovering inner structure and dynamics of the electron)
- a possible self (compressive and expansive) movement creating magnetic field due to movement of charges: unknown but the origin of the electromagnetism phenomenon was exclusively attributed to the intrinsic mechanics of the electron itself

- the inner structure: unknown
- the outer structure: known and accepted as perfectly spherical theoretically and measured in perfect or near perfect spherical shape, slightly aspheric or surprisingly spherical shape in some experiments [12]. This means that an electron may have two shapes; either spherical or aspherical or both (swinging between them)
- interaction with the photon(s): little known but requires a knowledge of how the photon is ejected at the speed of light while the photon is almost still (static) inside the electron
- interaction with the photon (kicking) by an electrostatic potential: unknown (so far) because the photon does not have a charge and any weight
- repulsion and attraction between electrons (and positrons): known superficially but its origin requires the intrinsic structure and mechanics of the electron itself
- behaviour in magnetic (& electrostatic) field: known superficially (circular or helical motion depending on initial conditions like static and accelerated); it appears that a possible intrinsic tilt angle (θ) may arise from the electron's net or resultant magnetic fields
- deficiencies and inconsistencies of the proposed conceptual models in the literature: too many deficiencies and inconsistencies [6-11] not properly explaining the intrinsic spin concept and the vital relationship with the photon. A full comparison with this study will easily reveal the deficiencies and inconsistencies.

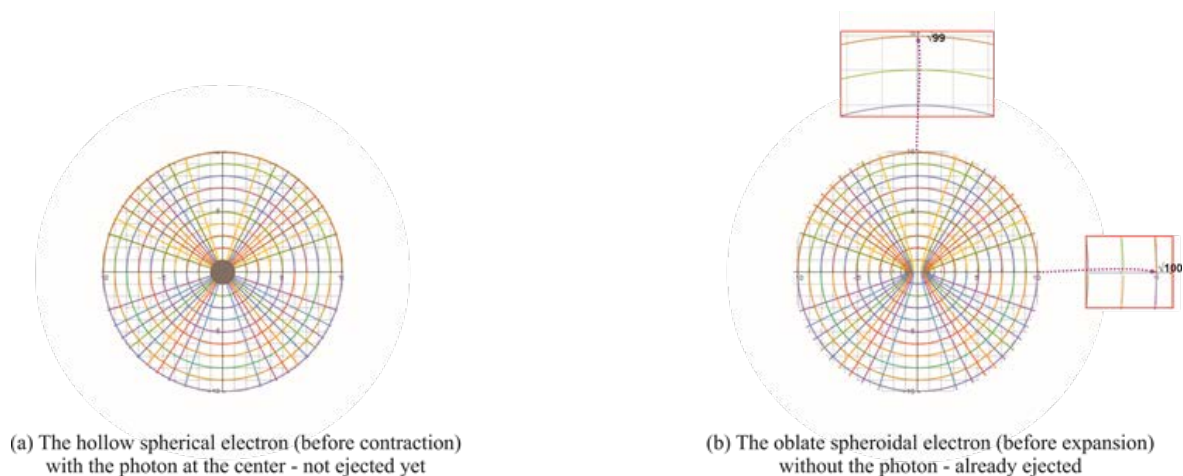


Figure 1 The electron as a negative charged hollow sphere (with arrows pointing radially inwards and with equal charge density distribution) continuously contracts (to be oblate spheroid) and expands (or relaxes to be perfect sphere again) to create magnetic fields and ejects the photon (at the speed of light) entering in hollow part of the spherical electron by the compressive and expansive mechanical forces in resonance created by magnetic forces due to moving charges of the electron. While the electron continuously does contraction and expansion in resonance, (a) the radial lines (or the cones in 3D) represent electric field intensity and the spherical shells represent electric potentials in expansion mode and (b) the hyperbolas (or the hyperboloids of one sheet in 3D) of one sheet represent electric field intensity and the spheroidal shells represent electric potentials in contraction mode (charge density is not equally distributed any more in contraction). Here the ratio of the radius of the photon (the hollow part of the electron sphere) and the electron is taken as 1/10 which will be very important for the compressive and expansive resonance is explained later on.

By considering the items listed, a first suggestion as a photofit is as follows. A slightly aspheric or surprisingly spherical shape of the electron's outer shape (in the experiments) connotes that the electron's outer shape swings between a spherical and a aspherical shape which would be very difficult to discriminate during experiments. Here the spherical means an hollow spherical (may be defined by the Hollow Spherical Coordinate System: HoSpCS) structure and aspherical means oblate spheroid (may be defined by the Oblate Spheroidal Coordinate System: OSCS) (App. A).

Here, a numerical example may be given for clarity. If the radius of hollow sphere (figure 1a) is $\sqrt{10^2} = 10$ then the vertical radius of the oblate spheroid (due to the collapsing action of the inner sphere having radius 1) is $\sqrt{10^2 - 1} \approx 9.95$ which is very difficult to discriminate or hard-to-detect (figure 1b) in the small sizes of electrons such as 2.8×10^{-15} m (whether it is a sphere or an oblate spheroid,) from outside look (the Prolate Spheroidal Coordinate System - PSCS is here avoided or not preferred intuitively. While the OSCS has a singular point at $\rho = a$ only, the PSCS has a singular line for $-a \leq z \leq a$ which must be considered during field calculations).

So the electron as negative charged hollow sphere continuously (intrinsically) contracts (to be oblate spheroid) and expands (or relaxes to be perfect sphere again) to create magnetic fields and ejects one photon (only one at a time and at the speed of light) residing in the hollow part of spherical electron by the compressive and expansive mechanical forces in resonance created by magnetic forces due to moving charges of the electron (figure 1).

III Dynamical Behaviour of the Electron and Its Interaction with the Photon

Negative charges of the electron are equally distributed in the hollow spherical electron. Small bit of charges forming the electron are fixed in a gel-like matrix structure (that provides structural support, encapsulates electrostatic charges against electrostatic repulsion forces for controlled compression & expansion in resonance with excellent compressibility and expansivity properties). Figure 2a shows the cones with arrows pointing radially inwards representing the electrostatic field intensity surfaces and the spherical shells representing the equipotentials.

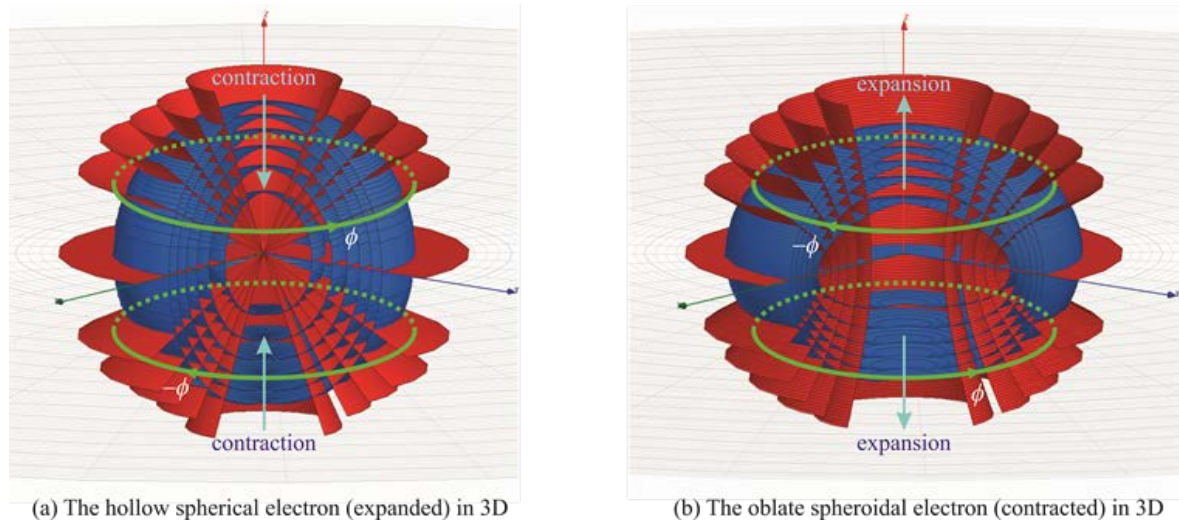


Figure 2 The contraction and the expansion (due to electrostatic & magnetic attractive and repulsive forces due to moving charges) of the hollow spherical electron

When the intrinsic contraction starts (meaning the innermost hollow sphere also starts to be a disc at the center) the movement of negative charges in opposite direction of z axis cause electrical currents (in $\pm z$ directions) creating small loops of magnetic fields in azimuthal ϕ directions. These loops of magnetic fields cause a compressive (due to the attractive electromagnetic forces) action on the radial cones making them as much as close and together. The individual (upper and lower) resultant magnetic fields are in opposite azimuthal ϕ directions below and above z axis. While the compression due to the contraction of negative charges continues, the photon (with an infinitesimal weight) inside the hollow part of the hollow spherical electron is ejected at the speed of light. The photons without any electrostatic charge are vastly available everywhere in the universe and continuously enter freely (not by any attraction and in any direction) in the hollow part of the electron (it looks that the electron can not live without a photon). There must be infinitesimal weight of the photon contrary to the literature, a photon without a weight is impossible to be ejected. After ejection of the photon, the cones become the hyperboloidal surfaces of one sheet (figure 2b) and the innermost hollow sphere becomes an imaginary disc of $\rho = a$ at $z = 0$ (table 1).

Figure 2b shows the hyperboloids of one sheet pointing inwards representing the electrostatic field intensity surfaces and the oblate spheroidal shells representing equipotentials.

Now there is an electrostatic force on each side of the imaginary disc: this is an electrostatic repulsion due to like charges at $z = 0$ bounded by $\rho = a$. Under the influence of these repulsive forces, the imaginary disc at $z = 0$ starts to be the innermost hollow sphere, the spheroidal shells expand to be spherical shells again and the hyperboloids of one sheet become the cones again. During the expansion the direction of the currents and the magnetic fields are also reversed (figure 2b). This compressive and expansive action in resonance continues throughout life of the electron or an annihilation with a positron will cease it by destroying. The net resultant magnetic field at $z = 0$ plane is zero as expected.

As the innermost sphere transforms into a disc and vice versa, the z -component of the magnetic field due to the movement of charges, though small, is in the attractive direction. This situation is similar to two semi-infinite conductors carrying current in opposite directions approaching each other end-to-end. At this point, the magnetic field has completely disappeared because all negative charges have stopped moving at $z = 0$ plane.

The repulsive electrostatic forces are smaller than the dominant magnetic attractive forces during the contraction and the dominant repulsive electrostatic forces are larger than the magnetic attractive forces during the expansion.

Here the ratio of the radius of the photon (the hollow part of the electron sphere) and the electron is taken as 1/10 which will be very important for the resonance of the contraction and expansion is discussed in the results and discussions section.

Table 1 During the contraction, the radius or size of spherical shells in z axis are reduced (or collapsed) to be spheroidal shells. When the innermost radius of hollow spherical shell is 1, it becomes a disc of $\rho = a = 1$ at $z = 0$ due the collapsing action. The dimensional displacement in the inner part, closer to the center, is greater than that in the outer part. For example, while the dimensional displacement of the innermost hollow spherical shell is 1, the dimensional displacement of the outermost spherical shell is 0.0501 which is very difficult to discriminate or hard-to-detect, in the small sizes of electrons such as 2.8×10^{-15} m (whether it is a sphere or an oblate spheroid).

Radius of spherical shells in z axis	Radius of spheroidal shells in z axis
$\sqrt{100} = 10$	$\sqrt{10^2 - 1} \approx 9.9498$
$\sqrt{81} = 9$	$\sqrt{9^2 - 1} \approx 8.9442$
$\sqrt{64} = 8$	$\sqrt{8^2 - 1} \approx 7.9372$
$\sqrt{49} = 7$	$\sqrt{7^2 - 1} \approx 6.9282$
$\sqrt{36} = 6$	$\sqrt{6^2 - 1} \approx 5.9160$
$\sqrt{25} = 5$	$\sqrt{5^2 - 1} \approx 4.8989$
$\sqrt{16} = 4$	$\sqrt{4^2 - 1} \approx 3.8729$
$\sqrt{9} = 3$	$\sqrt{3^2 - 1} \approx 2.8284$
$\sqrt{4} = 2$	$\sqrt{2^2 - 1} \approx 1.7320$
$\sqrt{3} = 1.7320$	$\sqrt{\sqrt{3}^2 - 1} \approx 1.4142$
$\sqrt{2} = 1.4142$	$\sqrt{\sqrt{2}^2 - 1} \approx 1.0000$
1	$\sqrt{1^2 - 1} = 0.0000 \rightarrow \text{disc}$

IV Geometric Explanation of the Intrinsic Compressive & Expansive Spin ($\frac{1}{2}$) of the Electron

The quantum spin is defined as the number of rotations required by a particle to regain its original state and look exactly same. Mathematically, a spin $\frac{1}{2}$ particle or the electron must be rotated by 720° (not 360°) to return to its original state (figure 3). There was not a classical analog of an electron's spin so far. Since spin concept in this photofit or conceptual electron model is no longer thought as angular, it is called as intrinsic compressive & expansive type spin. During the continuous contraction and expansion in resonance, the intrinsic compressive & expansive spin varies as $+\frac{1}{2}$ and $-\frac{1}{2}$ (figure 3). There are some instants in which the electron has no internal movement meaning that the electron does not produce any intrinsic compressive & expansive magnetic fields. These instants (spin reversing points from $+\frac{1}{2}$ to $-\frac{1}{2}$) are when the electron is in full spherical shape and when the electron is in full oblate spheroidal shape.

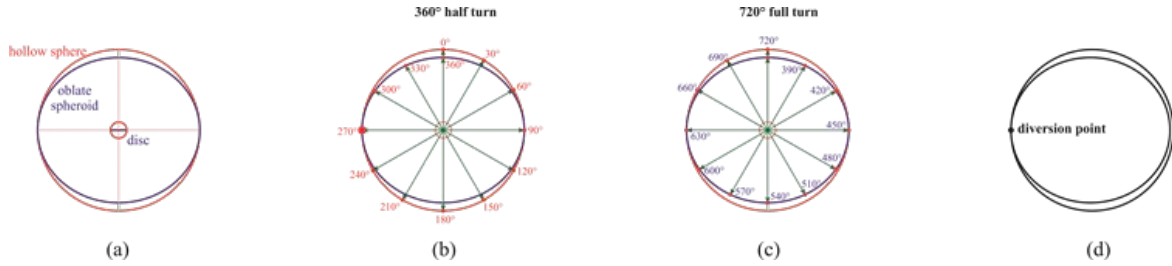


Figure 3 (a) The electron as an hollow spherical charge distribution continuously contracts to be oblate spheroid and expands (or relaxes) to its original hollow spherical shape (the vertical radius of oblate spheroid is drawn intentionally smaller exaggeratedly to show its line thickness which normally is hard to detect in its exact size). While the outer spherical shell is contracted to be outer oblate spheroidal shell, the innermost hollow spherical shell is contracted (or collapsed) to be a disc of $\rho = a = 1$ at $z = 0$. The contraction and the expansion in a continuous sequence or in resonance are realised by electromagnetic forces explained earlier. (b, c) A particle with an integer number spin comes back to the same state after rotating around once or 360° . A particle with $\frac{1}{2}$ integer spin comes back to minus its starting state after a whole rotation. It has to rotate twice to get back to the starting state. Since the electron is a fermion with spin $\frac{1}{2}$, it comes back to minus its starting state after a whole rotation and it has to rotate twice to get back to the starting state. The electron as a sphere starts to spin at 0° and after rotating 360° it becomes an oblate spheroid (due to a continuous contraction and expansion in resonance), it gains its original state at another 360° rotation as sphere. (d) A total 720° is shown as a Dirac's belt trick with diversion point at 270° (right hand side is zoomed to show the edges of the sphere and the spheroid are not touching each other). During the continuous contraction and expansion in resonance, the intrinsic compressive & expansive spin varies as $+\frac{1}{2}$ and $-\frac{1}{2}$.

V Results and Discussions

The humble looking electron almost does not hide any surprises anymore in its depths by the photofit or conceptual (thought) model proposed in this study. Some answers to the endless questions and unknowns about the electron and the photon (which are main motivation of this study) as a matter of curiosity are revealed and clarified as results and discussions as follows.

- The electron has a dynamic structure swinging between a perfect sphere and an oblate spheroid by the contraction and the expansion (to relax its original spherical shape & state). The compressive & expansive movements of electrostatic charges inside the electron cause attractive and repulsive electrostatic & magnetic forces which eject the photon (while it is almost still or static inside the electron) at the speed of light. The ejection is directly carried out by a mechanical compressive & expansive action of the electrostatic & magnetic forces, not directly from the electrostatic and magnetic forces themselves. The photons without any electrostatic charge are vastly available everywhere in the universe and continuously enter freely (not by any attraction and from any direction) in the hollow part of the spherical electron (it looks that the electron can not live without a photon). There must be infinitesimal weight of the photon contrary to the literature, a photon without a

weight is impossible to be ejected mechanically. Even though their effects are small, any gravity also influences the dynamic structure of an electron, which has weight.

- Since there is no spin (rotation) of the electron, the spin concept is no longer thought as angular but it is the intrinsic compressive & expansive type (by revealing and showing the inner structure and dynamics of the electron).
- Mathematically, a spin $\frac{1}{2}$ particle or the electron must be rotated by 720° (not 360°) to return to its original state. There was not a classical analog of an electron's spin before. It is graphically proved and shown by using a combination of a sphere and a spheroid inside it (similar to Dirac's belt trick).
- The electron has an individual (upper and lower) resultant intrinsic magnetic fields (figure 2) due to the compressive & expansive movements of the electrostatic charges inside it causing an attractive and repulsive electrostatic & magnetic forces. Its originally created magnetic fields as small loops are in azimuthal directions and the individual (upper and lower) resultant magnetic fields are also azimuthal (ϕ) or circular directions. The individual resultant magnetic fields are no longer look like bar magnets as widely accepted before. The **net** (spacial resultant of the individual azimuthal magnetic fields creating torque) resultant magnetic field of the electron is sensitive to the directions of external magnetic fields (when two magnetic fields interact, they combine, bend, or oppose each other based on their orientation, leading to attraction, repulsion, or reconfiguration of field lines. Parallel, same-direction fields add up to create a stronger, combined field, while opposite-direction fields subtract from each other; table 2 and figure 4) and depends on also its dynamical conditions whether it is static or accelerated which cause it to behave in a circular or a helical motion (The net resultant of the individual upper and lower azimuthal magnetic fields under external magnetic fields may cause an intrinsic tilt angle, θ). However, during being kicked by the photons and the ejection of the photon there may be transient magnetic (& electrostatic) fields contributing the net resultant magnetic fields. The (individual or net) resultant magnetic fields of the electron is also affected by orbital movements of the electron (causing standing waves) and the presence of other electrostatic charges and acceleration (and precession) by high density electrostatic & magnetic fields. The presence of high density electrostatic & magnetic fields also causes a change in the electron's resonance frequency; consequently, the photon's ejection frequency. It is likely that all these disruptive effects due to the external electrostatic and magnetic fields (and gravitational effects) have a small distortion effect on the spherical shape of the electron.
- The positron's spin is opposite of the electron's spin. The contraction and expansion (in resonance) are in reverse order for the case of the positron as may be guessed.
- The electron interacts with the photon by a mechanical kicking action (not due to electrostatic effect). When a photon kicks an electron, the kick changes electron's position. The electron looks sensitivite to angular incident & reflection (θ and ϕ) positions of the incoming photon depending on the electron has a photon inside or not (the angular sensitivity may show itself as the photoelectric effect and the Compton scattering).
- Deficiencies and inconsistencies of the proposed conceptual models in the literature may be seen easily by a comparison with this study. None of the conceptual models has an ability to eject the photons at the speed of light by compressive forces (not properly explaining the intrinsic spin concept and the vital relationship with the photon as well).
- Each electron can produce or emit an electromagnetic field and wave that may extend throughout space continuously (not as wave packet) while ejecting the photons synchronously. That means the wave-particle duality of the photon is a separable property. They may be thought independently or as separate entities (even though these are synchronized). But the wave-particle duality of the electron is still exist, they are inseparable entities.

Table 2 The effects of the directions of external magnetic fields on the electron's individual (upper and lower) and net magnetic field (causing magnetic field subtraction or addition) on azimuthal ϕ angles. The **net** spacial resultant (of the individual azimuthal magnetic fields) magnetic field of the electron is sensitive to the $(\pm x, \pm y, \pm z)$ directions of external magnetic (& electrostatic) fields (the external electrostatic fields are not considered here). When the directions of external magnetic fields are in $\pm z$ directions then the electron experiences no magnetic field subtraction or addition on its azimuthal ϕ angular positions (thereby no force and torque). When the directions of external magnetic fields are $\pm y, \pm z$ directions then the electron experiences magnetic field subtraction or addition on its azimuthal ϕ angular positions causing an attraction & repulsion creating tilting (θ , tilt angle) and precession torques (which cause it to behave in a circular motion if it is static or a helical motion if it is accelerated). Unit vector relationship between the Cartesian and the Cylindrical coordinates: $\vec{a}_\phi = -\vec{a}_x \sin \phi + \vec{a}_y \cos \phi$

Azimuthal angles	Directions of individual (upper and lower) magnetic fields (fixed)		Directions of individual and net (resultant) magnetic fields depending on directions of external magnetic field (magnetic field subtraction or addition is possible on some azimuthal ϕ angular positions)		
ϕ	$\pm\phi$		$\pm x$	$\pm y$	$\pm z$
0°	Contraction	$+\phi$	$+y$ and $\mp x$	$+y$ and $\mp y$	$+y$ and $\mp z$
		$-\phi$	$-y$ and $\mp x$	$-y$ and $\mp y$	$-y$ and $\mp z$
	Expansion	$-\phi$	$-y$ and $\mp x$	$-y$ and $\mp y$	$-y$ and $\mp z$
		$+\phi$	$+y$ and $\mp x$	$+y$ and $\mp y$	$+y$ and $\mp z$
90°	Contraction	$+\phi$	$-x$ and $\mp x$	$-x$ and $\mp y$	$-x$ and $\mp z$
		$-\phi$	$+x$ and $\mp x$	$+x$ and $\mp y$	$+x$ and $\mp z$
	Expansion	$-\phi$	$-x$ and $\mp x$	$-x$ and $\mp y$	$-x$ and $\mp z$
		$+\phi$	$+x$ and $\mp x$	$+x$ and $\mp y$	$+x$ and $\mp z$
180°	Contraction	$+\phi$	$-y$ and $\mp x$	$-y$ and $\mp y$	$-y$ and $\mp z$
		$-\phi$	$+y$ and $\mp x$	$+y$ and $\mp y$	$+y$ and $\mp z$
	Expansion	$-\phi$	$+y$ and $\mp x$	$+y$ and $\mp y$	$+y$ and $\mp z$
		$+\phi$	$-y$ and $\mp x$	$-y$ and $\mp y$	$-y$ and $\mp z$
270°	Contraction	$+\phi$	$+x$ and $\mp x$	$+x$ and $\mp y$	$+x$ and $\mp z$
		$-\phi$	$-x$ and $\mp x$	$-x$ and $\mp y$	$-x$ and $\mp z$
	Expansion	$-\phi$	$+x$ and $\mp x$	$+x$ and $\mp y$	$+x$ and $\mp z$
		$+\phi$	$-x$ and $\mp x$	$-x$ and $\mp y$	$-x$ and $\mp z$
			magnetic field subtraction or addition at $\phi = 90^\circ$ and $\phi = 270^\circ$	magnetic field subtraction or addition at $\phi = 0^\circ$ and $\phi = 180^\circ$	no magnetic field subtraction or addition

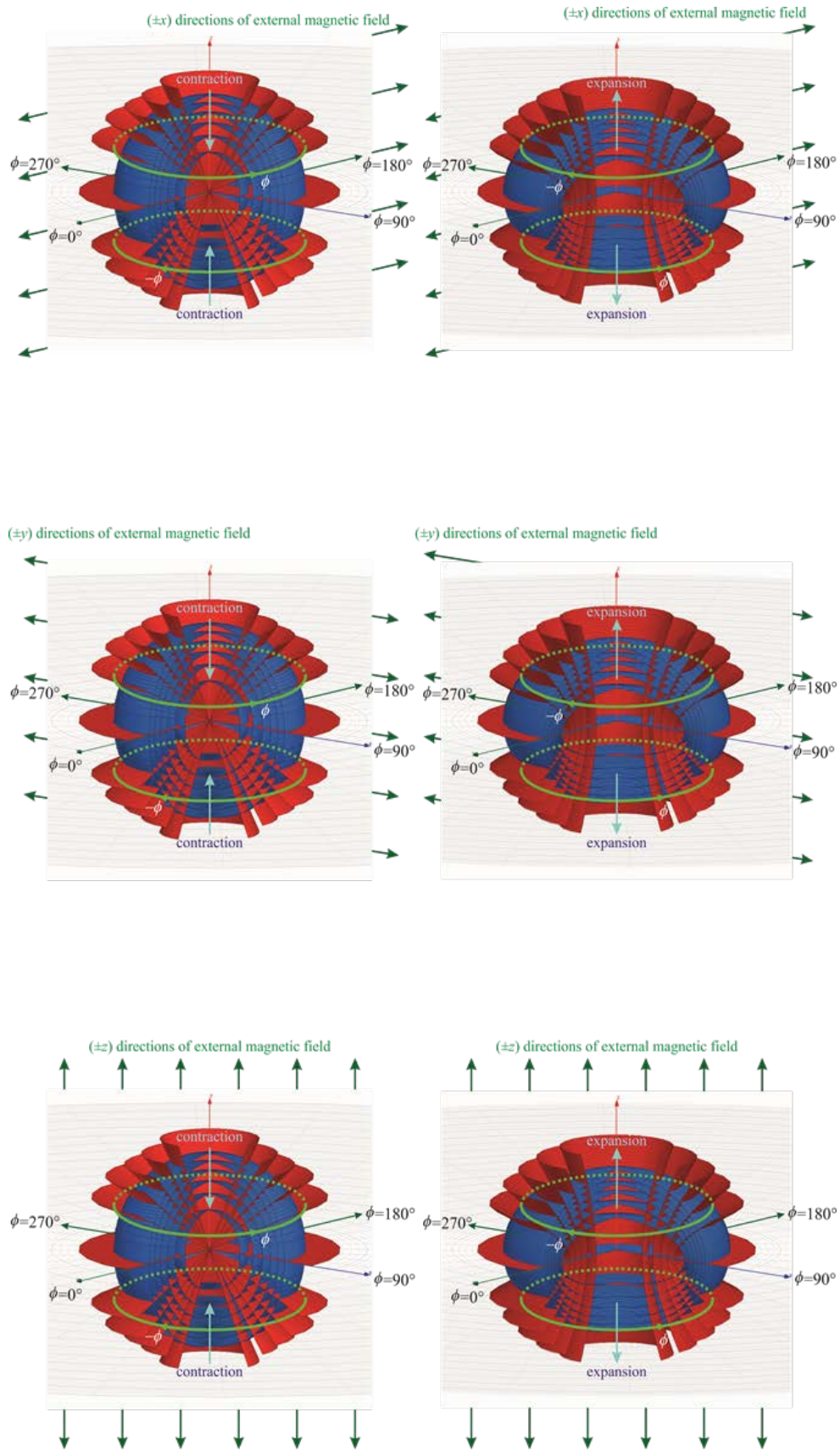


Figure 4 The directions of individual and net spacial (resultant) magnetic fields depend on the $(\pm x, \pm y, \pm z)$ directions of external magnetic fields; the electron experiences magnetic field subtraction or addition on its azimuthal ϕ angular positions depending on the external magnetic fields.

- Due to natural behaviour of the photon, the quantum uncertainty and probability now has an reasonable explanation. The photon (actually without wave-particle duality) is ejected by the compressive & expansive action of the electrostatic & magnetic forces which are a resultant of many electrostatic & magnetic forces, not solely electron's field itself. So it is impossible to estimate where the photon in a continuous wave (not a wave packet). This is the reason why the quantum world is probabilistic rather than deterministic (uncertainty).
- Similar comments for the electron's wave can be written as above. The electron (actually with a wave-particle duality) emits wave that may extend throughout space continuously (not as a wave packet). The compressive & expansive action of the electron is also affected by outside forces like incident photons, other electrons & positrons and nearby charges, electrostatic and magnetic fields. This is the reason why the quantum world is probabilistic (uncertainty) rather than deterministic. The intrinsic compressive & expansive spin of the electron (continuously changing its direction and magnetic field) is also another factor that contributes the probabilistic quantum world.
- In order to understand or explain the quantum uncertainty and probability, one must first look not at the wave & particle itself, but at the source -and disturbances and intrinsic behaviour- from which the wave & particle originates. The quantum particles are known as constantly interacting with each other since they are in a state of continuous vibration.
- When a photon emitted from an electron in a metallic conductor carrying current hits or impacts another electron, it creates a severe impact on the electron (causing a recoil). While free electrons drift in the metallic conductor, the photon travels from an electron to another electron at the speed of light. This is why electricity is called a **severe impact**.
- If a photon is ejected from an electron at the speed of light, it seems likely that there may be other quantum (geometrical) mechanisms capable of launching some particles faster than the speed of light.
- The electrons (and the positron) possess an intrinsic inner electrostatic repulsive forces (which its main cause may be a subject of further research). The electron's field is neither pure electrostatic nor pure magnetic (due to its intrinsic compressive and expansive nature) and it is a combination of both.
- The repulsion and the attraction between the electrons (and the positrons) are due to the combination of its intrinsic electrostatic and its intrinsic magnetic fields (mainly) and mechanical forces (recoiling) caused by the kicking of photons. The kicking effects of photons are entirely in the repulsive direction (called as photon exchange) contrary to some literature [13,14]. The exchange photons are almost face-to-face (repulsive analogy of two people passing a ball back and forth on their small own boats) direction for any charge couples (like and unlike charges). So there is no place for a back-to-back (reverse) photon exchange or emission for unlike charges causing attraction (attraction analogy with boomerangs). If the repulsive force between electrons resulted solely from the exchange of photons, then there would be no repulsive force within (internal structure of) the electron where there is no photon exchange.

VI Conclusions

The nature and the essence of the electron was central to the development of quantum theory. Properties of the electron like charge, mass and spin could be measured, but nobody knew what caused them. The electrons were therefore believed by many to be weird point particles with no substructure, to which their properties were simply attached. The origin of the electromagnetism phenomenon (unknown exactly so far) in general was exclusively attributed to the intrinsic (unseen) mechanics of the electron itself. There is even really not having a good picture for what spin for point particles means (due to counter-intuitive behavior of the electron accepted as a point particle). The reason is probably that the electron is constrained by the concept of point particle material structure. Later on, the literature has got more conceptual electron models like vortex, toroidal and Hubius helix, etc. shapes but still with deficiencies and inconsistencies not properly

explaining the intrinsic spin concept and the vital relationship and the interaction between the electron and the photon. It was thought that the humble looking electron may be hiding some surprises in its depths. A physical photofit or conceptual (thought) model of the electron is derived from theoretical and experimental physics papers in this study. This model is intuitively believed to reveal a new intrinsic magnetic (spin) properties of the electron and the vital relationship and the interaction between the electron and the photon. In the photofit model, the electron as a negative charged hollow sphere continuously contracts (to be oblate spheroid) and expands (or relaxes to be perfect sphere again) to create magnetic fields and ejects photons (at the speed of light) entering in hollow part of the spherical electron by the compressive and expansive mechanical forces (in resonance) created by the electrostatic and magnetic attractive and repulsive forces due to moving charges of the electron. A new reasonable concept of intrinsic magnetic spin is also provided due to the compressive & expansive movement of charges inside the electron. So spin concept is no longer thought as angular but the intrinsic compressive & expansive type.

The electron should never be considered as a point-like particle and it does not actually rotate around its own axis to produce its magnetic field by movements of its intrinsic electrostatic charge.

VII Future Work

Future work follows an analytical calculation of an optimum $r_{\text{electron}} / r_{\text{photon}}$ ratio of the spherical electron (and photon) in a gel-like matrix structure with excellent compressibility and expansivity properties and the dynamical behaviour of the electron (by considering gravitational effects as well). Here the ratio $r_{\text{electron}} / r_{\text{photon}} = 10$ is taken intuitively but the exact ratio may be still around $r_{\text{electron}} / r_{\text{photon}} \approx 10$ to be determined by resonance conditions after some analytical (and possible numerical) calculations.

This study may be repeated for considering the PSCS version of the contracted hollow spherical electron which would be a fantastic kind of problem for the electromagnetic field theory or physics courses.

VIII Acknowledgements

The author would like to express his sincere thanks to Prof. Dr. İlhan Tarimer (at The University of Muğla Sıtkı Koçman, Muğla, Turkey, www.mu.edu.tr) for his invaluable philosophical* discussions about quantum physics.

*Sometimes progress in physics requires first backing up to reexamine, reinterpret and revise the theories that we already have. To do this kind of research, we need scholars who blend the roles of physicist and philosopher, as was done thousands of years ago in Ancient Greece [15].

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X Appendix Properties of the SpCS, the HoSpCS and the OSCS used in the study [16-18]

Properties of the SpCS, the HoSpCS and the OSCS used in the study are given in tables A1-A3 and figures A1-A4.

Table A1 Properties of the SpCS (r, θ, ϕ)

Constant spheres	Constant cones	Constant planes
$\frac{\rho^2}{r^2} + \frac{z^2}{r^2} = 1$	$\frac{\rho^2}{\sin^2 \theta} - \frac{z^2}{\cos^2 \theta} = 0$	$\phi = \tan^{-1}(y / x)$
$z^2 = r^2 - \rho^2$	$z = \rho / \tan \theta$	
Limits of variables		
$0 \leq r \leq \infty$	$0 \leq \theta \leq \pi$	$0 \leq \phi \leq 2\pi$
Traditional properties		
$\rho = r \sin \theta$	$z = r \cos \theta$	
Inverse properties		
$r^2 = \rho^2 + z^2$	$\cos \theta = z / r$	

Table A2 Properties of the HoSpCS (χ, μ, ϕ) . $r = a\sqrt{1 + \chi^2}$ and $\mu = \cos \theta$

Constant spheres	Constant cones	Constant planes
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$\frac{\rho^2}{a^2(1+\chi^2)}+\frac{z^2}{a^2(1+\chi^2)}=1$	$\frac{\rho^2}{a^2(1-\mu^2)}-\frac{z^2}{a^2\mu}=0$	$\phi=\tan^{-1}(y/x)$
$z^2=a^2(1+\lambda^2)-\rho^2$	$z=\frac{\mu}{\sqrt{1-\mu^2}}\rho$	
Limits of variables		
$0\leq\chi\leq\infty$	$-1\leq\mu\leq1$	$0\leq\phi\leq2\pi$
Traditional properties		
$\rho=a\sqrt{1+\chi^2}\sqrt{1-\mu^2}$	$z=a\sqrt{1+\chi^2}\mu$	
Inverse properties		
$\chi^2=\frac{\rho^2+z^2}{a^2}-1$	$\mu^2=\frac{z^2}{z^2+\rho^2}$	

Table A3 The OSCS (χ, μ, ϕ) . $r = a\sqrt{1+\chi^2}$ and $\mu = \cos \theta$

Confocal oblate spheroids	Hyperboloids of one sheet	Constant planes
$\frac{\rho^2}{a^2(1+\chi^2)}+\frac{z^2}{a^2\chi^2}=1$	$\frac{\rho^2}{a^2(1-\mu^2)}-\frac{z^2}{a^2\mu^2}=1$	$\phi=\tan^{-1}(y/x)$
$z=\chi\sqrt{a^2-\rho^2/(1+\chi^2)}$	$z=\mu\sqrt{\rho^2/(1-\mu^2)-a^2}$	
Limits of variables		
$0\leq\chi\leq\infty$	$-1\leq\mu\leq1$	$0\leq\phi\leq2\pi$
Traditional properties		
$\rho=a\sqrt{(1+\chi^2)(1-\mu^2)}$	$z=a\chi\mu$	
Inverse properties		
$\chi^2=\frac{(\rho^2+z^2)-a^2+\sqrt{4a^2z^2+(\rho^2+z^2-a^2)^2}}{2a^2}$ $\mu^2=\frac{a^2-(\rho^2+z^2)+\sqrt{4a^2z^2+(\rho^2+z^2-a^2)^2}}{2a^2}$		

The OSCS is well known in the literature. Here a graphical assisted approach follows to construct the OSCS from the HoSpCS on the SRSC [16-18] which provides easy drawing, constructing and commenting.

When the spherical shells of $\rho^2 + z^2 = r^2 = a^2(1+\chi^2)$ shown in figure A1

$$\frac{\rho^2}{a^2(1+\chi^2)} + \frac{z^2}{a^2(1+\chi^2)} = 1 \quad (A1)$$

are collapsed down (squared subtraction) to be $r^2 = a^2(1+\chi^2) - a^2 = a^2\chi^2$ in z axis, the spherical shells become confocal (also equipotential in electrical point of view) oblate spheroidal shells described by

$$\frac{\rho^2}{a^2(1+\chi^2)} + \frac{z^2}{a^2\chi^2} = 1 \quad (A2)$$

When the same method is applied in other axis, ρ the spherical shells become confocal (also equipotential in electrical point of view) prolate spheroidal shells described by

$$\frac{\rho^2}{a^2\chi^2} + \frac{z^2}{a^2(1+\chi^2)} = 1 \quad \text{or} \quad \frac{\rho^2}{a^2(\chi^2-1)} + \frac{z^2}{a^2\chi^2} = 1 \quad (A3)$$

The collapsing action in the direction of z converts the innermost spherical shell with $r = a$ to an infinitesimal thickness disc of $\rho = a$, in the direction of ρ the same spherical shell is converted into an infinitesimal thickness of a line element of length $z = 2a$.

While the spherical shells become the oblate and the prolate spheroidal shells by “squared subtraction” method, the cones of the HoSpCS described by

$$\frac{\rho^2}{a^2(1-\mu^2)} - \frac{z^2}{a^2\mu} = 0 \quad (\text{A4})$$

become

$$\frac{\rho^2}{a^2(1-\mu^2)} - \frac{z^2}{a^2\mu^2} = 1 \quad \text{hyperboloids of one sheet} \quad (\text{A5})$$

$$-\frac{\rho^2}{a^2(1-\mu^2)} + \frac{z^2}{a^2\mu^2} = 1 \quad \text{hyperboloids of two sheets} \quad (\text{A6})$$

for the OSCS and the PSCS respectively.

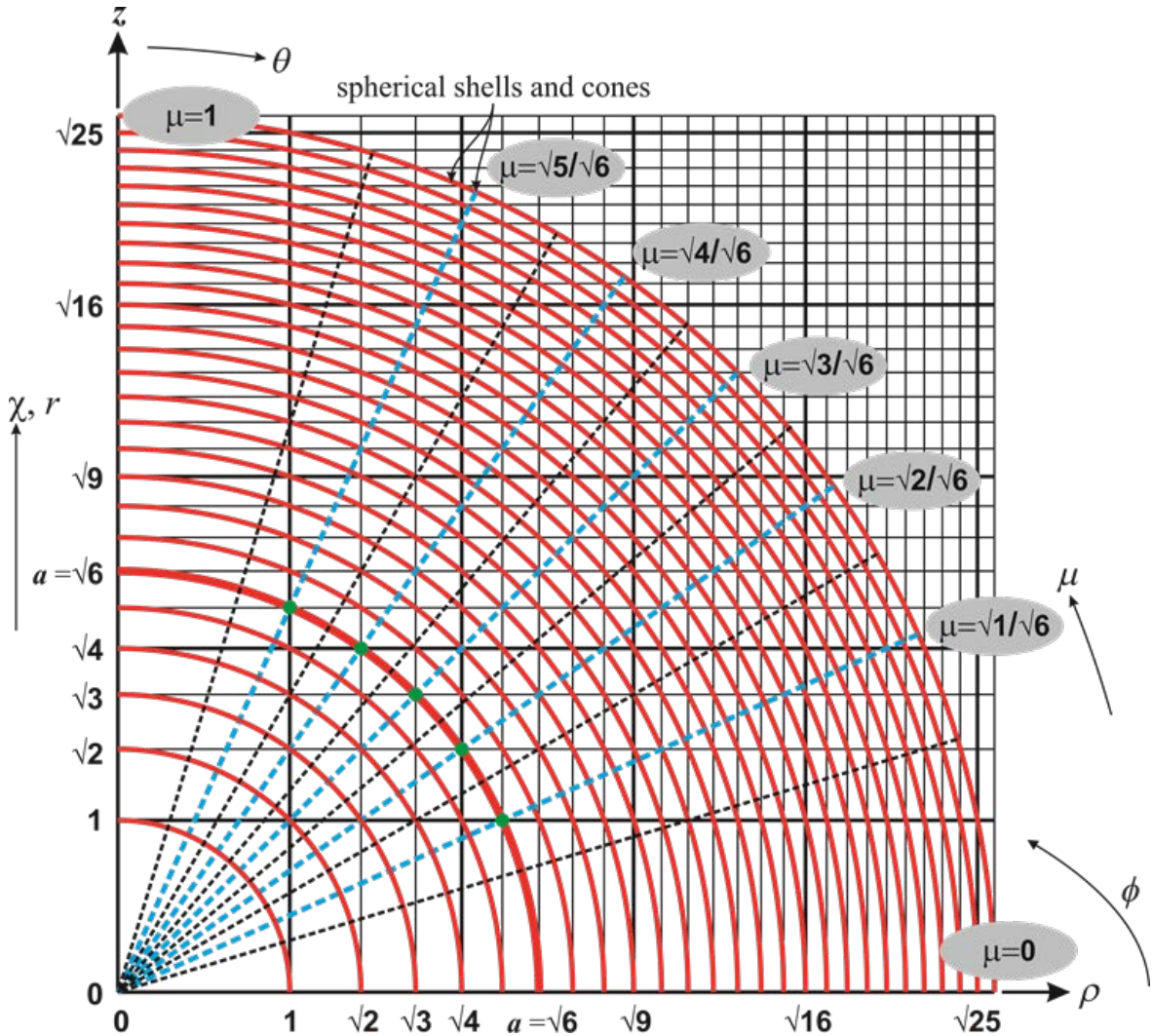


Figure A1 The SpCS (r, θ, ϕ) and the HoSpCS (χ, μ, ϕ) . In the figure $\mu = \sqrt{5/6} \rightarrow \theta = 24.09^\circ$, $\mu = \sqrt{4/6} \rightarrow \theta = 35.26^\circ$, $\mu = \sqrt{3/6} \rightarrow \theta = 45^\circ$, $\mu = \sqrt{2/6} \rightarrow \theta = 54.73^\circ$ and $\mu = \sqrt{1/6} \rightarrow \theta = 65.90^\circ$.

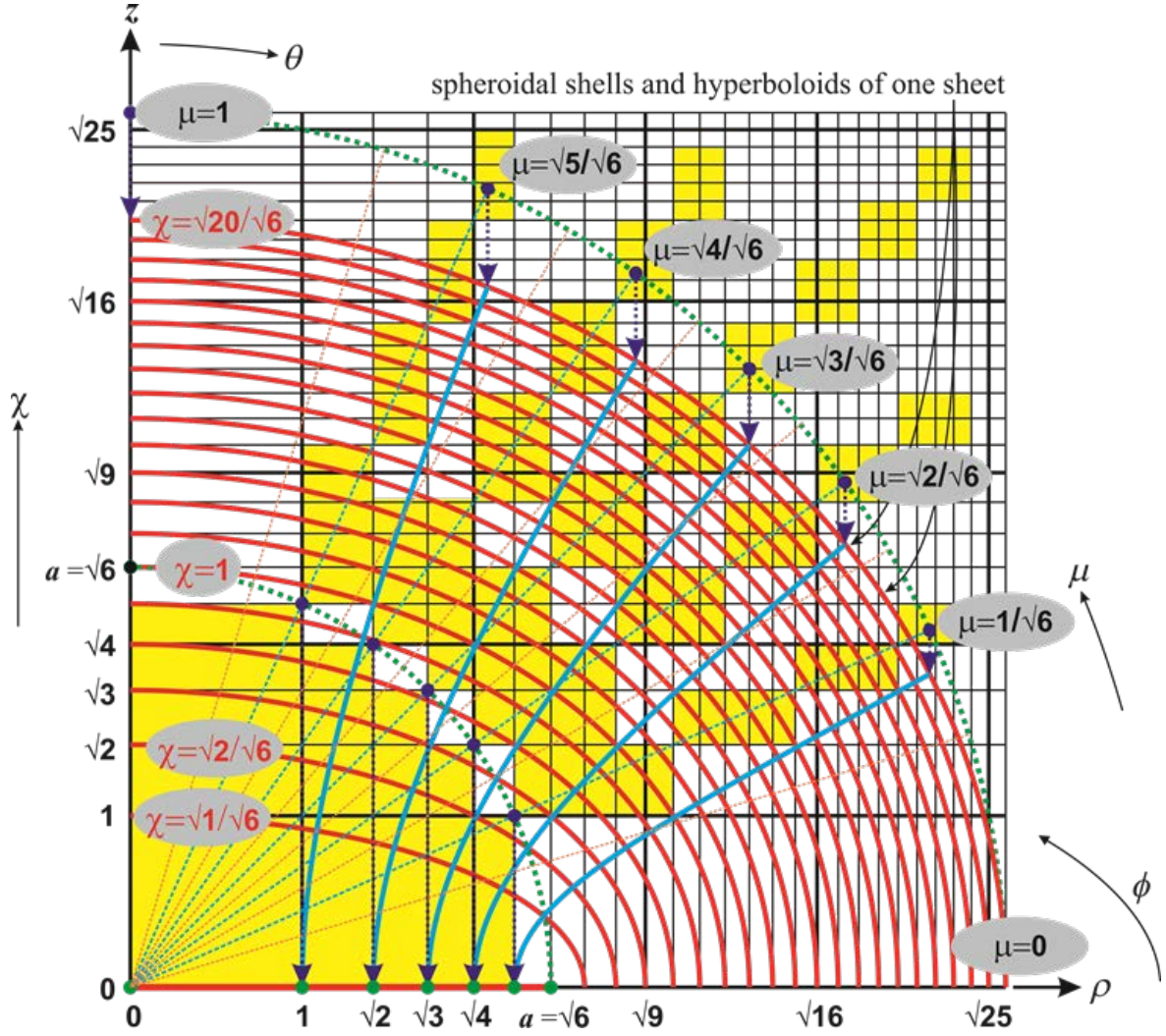


Figure A2 The OSCS (χ, μ, ϕ)

From the electrical point of view, the constant surfaces (r, θ, ϕ) in the SpCS may be created as equipotential surfaces (or shells) when a current flows in radial (r), polar (θ) and azimuthal (ϕ) directions respectively. When the same method is applied in oblate and prolate geometries, the constant surfaces (χ, μ, ϕ) in the OSCS and the PSCS may be created as equipotential surfaces when a current flows in longitudinal (χ), polar (μ) and azimuthal (ϕ) directions respectively.

Producing hyperboloids of one sheet, Eq.(A5) and hyperboloids of two sheets, Eq.(A6) without differential mathematics from Eq.(A4) is as below:

By rearrangement of the equations of spherical shells and the cones of the HoSpCS

$$\rho^2 + z^2 = a^2(1 + \chi^2) \rightarrow \begin{cases} z^2 = a^2(1 + \chi^2) - \rho^2 \\ \rho^2 = a^2(1 + \chi^2) - z^2 \end{cases} \quad (\text{A7a})$$

$$\frac{\rho^2}{a^2(1 - \mu^2)} - \frac{z^2}{a^2\mu^2} = 0 \rightarrow \begin{cases} z^2 = \rho^2 \left(\frac{\mu^2}{1 - \mu^2} \right) \\ \rho^2 = z^2 \left(\frac{1 - \mu^2}{\mu^2} \right) \end{cases} \quad (\text{A7b})$$

may be written. Where the cones and the spherical shells intersect at equal ρ is

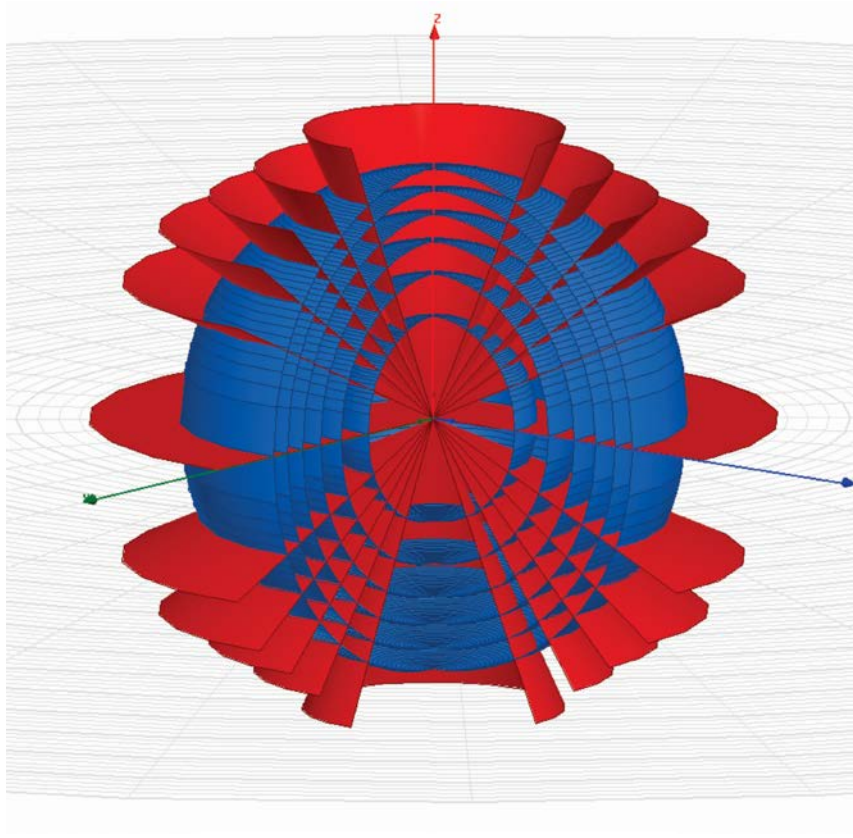


Figure A3 The SpCS in 3D

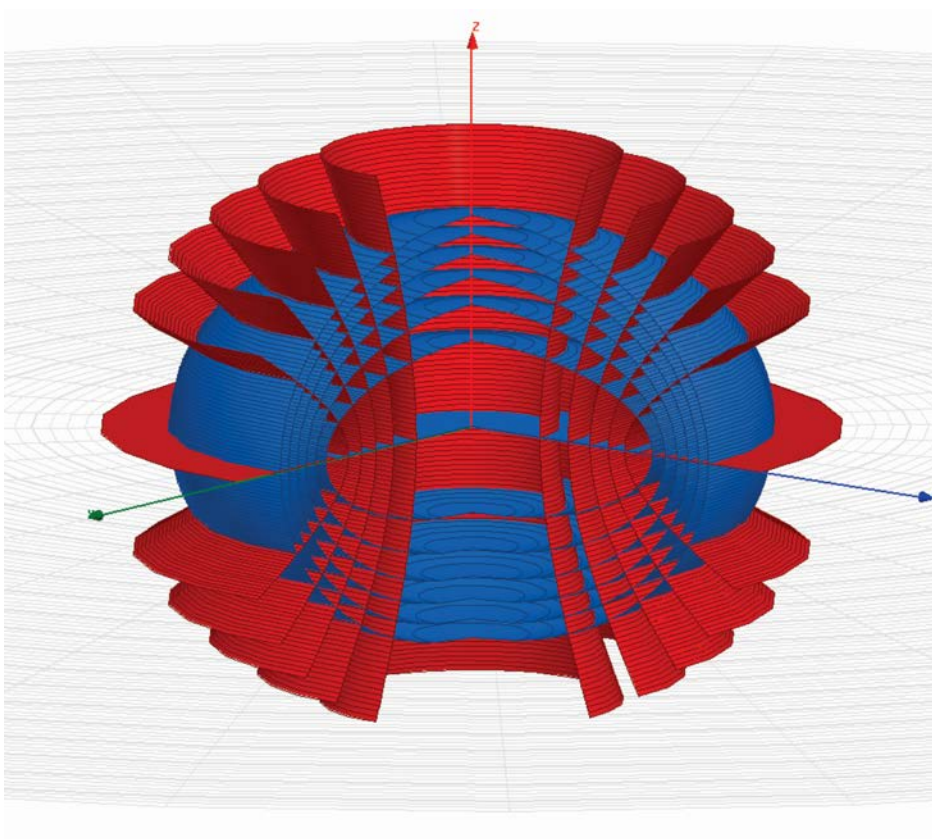


Figure A4 The OSCS in 3D

$$(\rho^2 = a^2(1 + \chi^2) - z^2) = \left(\rho^2 = z^2 \left(\frac{1 - \mu^2}{\mu^2} \right) \right) \rightarrow \begin{cases} z^2 = a^2(1 + \chi^2)\mu^2 \\ z^2 = a^2\mu^2 \text{ for } \chi = 0 \end{cases}$$

and where the cones and the spherical shells intersect at equal z is

$$(z^2 = a^2(1 + \chi^2) - \rho^2) = \left(z^2 = \rho^2 \left(\frac{\mu^2}{1 - \mu^2} \right) \right) \rightarrow \begin{cases} \rho^2 = a^2(1 + \chi^2)(1 - \mu^2) \\ \rho^2 = a^2(1 - \mu^2) \text{ for } \chi = 0 \end{cases}$$

By the “squared difference” (in z direction) between equations of the cones, Eq.(A7b) and the intersections for $\chi = 0$

$$z^2 = \rho^2 \left(\frac{\mu^2}{1 - \mu^2} \right) - a^2\mu^2 \text{ or } \frac{\rho^2}{a^2(1 - \mu^2)} - \frac{z^2}{a^2\mu^2} = 1$$

is obtained which is the equation of the hyperboloids of one sheet of the OSCS. The same method in direction ρ is applied to obtain the hyperboloids of two sheets of the PSCS.

XI About the Author

He finished his technical high school (electrical department) with an honours degree in 1980. He received his Bsc and MSc degrees in department of electrical engineering from the University of Gazi, Ankara, Turkey in 1984 and 1989 respectively. His PhD is from the department of electrical engineering, the University of Sussex in 1994, UK. He was early retired from the University of Gazi in February 2013 (at his 50). He currently lives in Manchester (UK) as a freelance consultant about electromagnetics.

He lectured a number of courses on electrical engineering (as assistant, associate and full professor) but now is specialized and settled down on electromagnetic field theory (for BSc Students) and field theory (for MSc and PhD Students). His early interests were (theoretical and practical) modelling & design of low-frequency electromagnetic devices (novel and traditional electrical machines & transformers & motors & generators & magnetic circuits & actuators & sensors) by using Infolytica Magnet-Elecnet-Gemini and Ansoft-Ansys Emag-Rmxprt, electrical & magnetic properties of materials, forensic electrical engineering. He supervised a number of BSc and PhD thesis on these subjects and published a number of books and papers (all of them are shared in www.researchgate.net/profile/Osman-Guerdal). His recent private interests now are ontology & metaphysics of electromagnetism and field theory (and Metaphysics Aided Intelligence: MAI). He is also very interested in sociology, psychology, teology, philosophy, metaphysics, etc. His life quote is

THE MENTALITY OF SCIENCE IS MUCH MORE IMPORTANT THAN THE SCIENCE ITSELF

BİLİM ZİHNİYETİ BİLİMİN KENDİSİNDEN ÇOK DAHA ÖNEMLİDİR